Power Plant Optimization

Why Focus On Energy / Utilities?

- Energy is the single largest operating expense after raw materials in the process industries
- “The best spend less than 50% on total energy cost compared to the worst.” (Solomon)
- Deregulation has opened up new opportunities / threats
- Linked to CO_2 / NO_X / SO_X
- Energy costs are rising in some regions

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Energy Optimization Goals

- Minimize Operating Costs / Maximize Profit while:
  - Meeting electrical, steam, hydrogen and offgas demands
  - Honoring operating/equipment constraints
  - Honoring contract constraints
  - Environmental concerns (NOx, CO, etc.)

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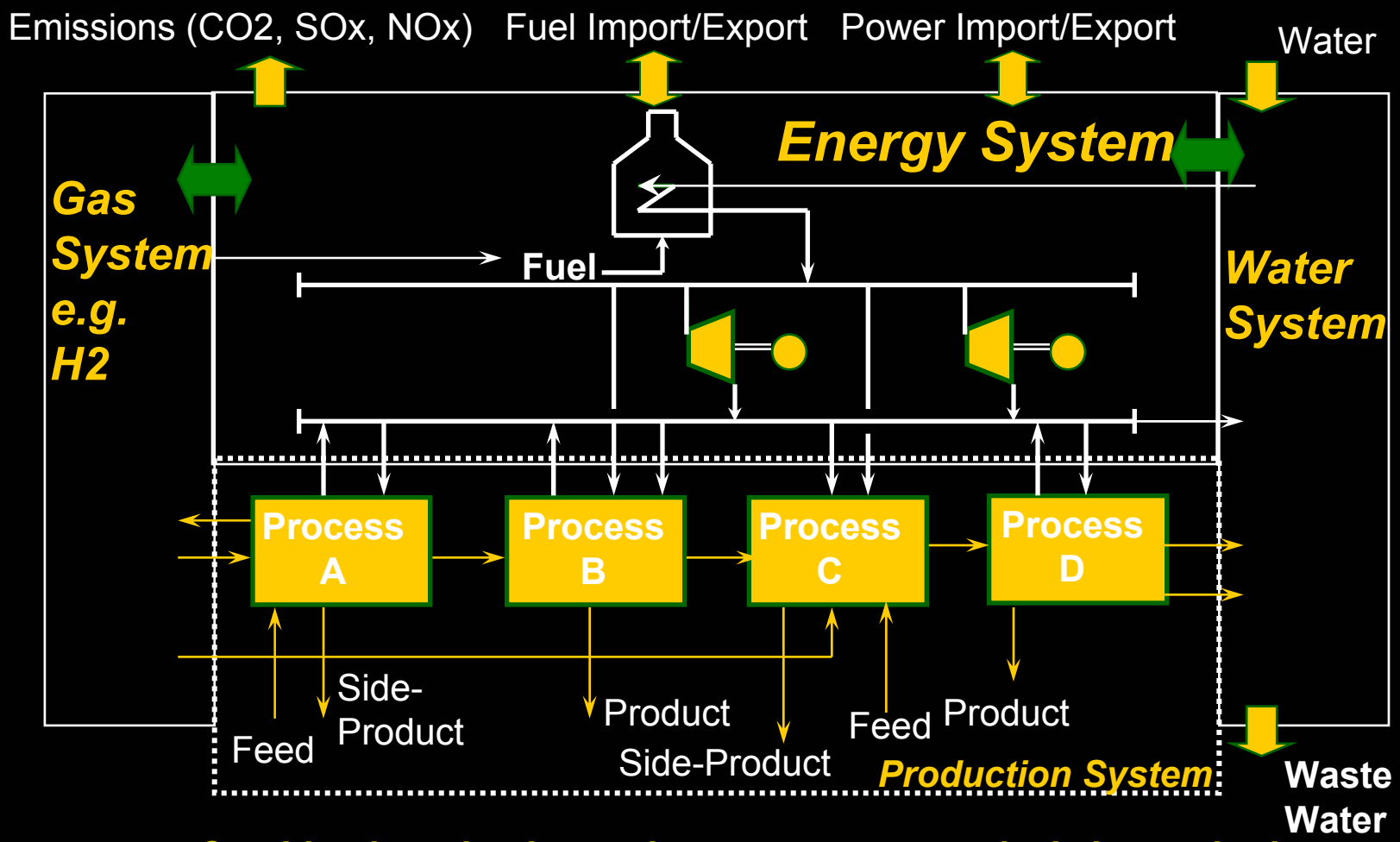
Site Wide Energy System



- *Combined production and energy system analysis is required*
- *Interactions between energy - water and off-gas system considered*
- *Constraints from out of site bound should be considered*

Utility System Operation Challenges

How much electricity should I purchase, how much could I sell and at what price?

Which boilers should I use and at what load should I run these boilers?

What fuels should I use and how much should I purchase – what contract?

At what load should I run the GTG?

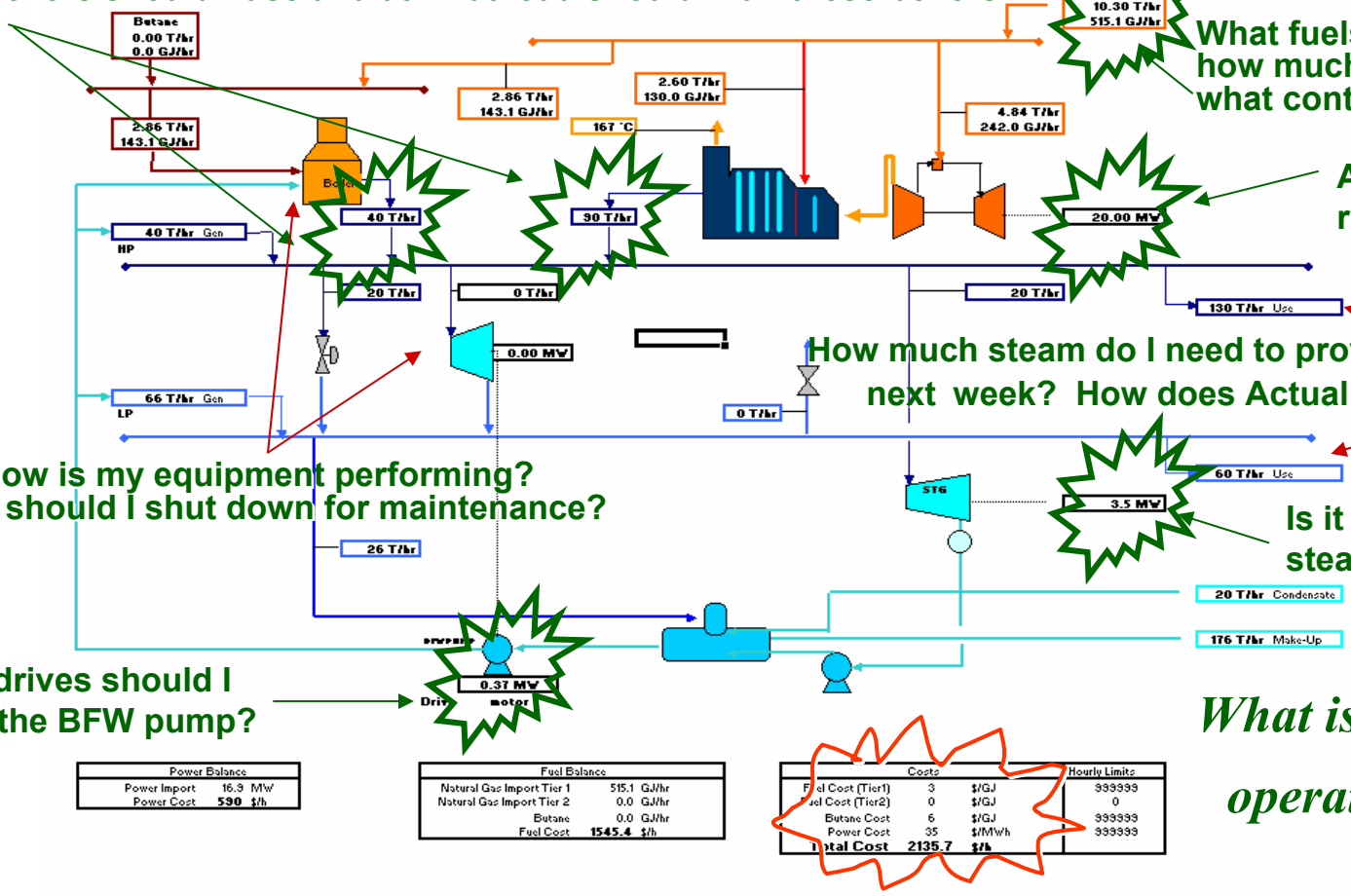
How much steam do I need to provide today, tomorrow, next week? How does Actual compare to Plan?

How is my equipment performing?
When should I shut down for maintenance?

Is it economic to run my steam turbine generator?

What drives should I use for the BFW pump?

What is the lowest operating cost?



- Many decisions to be made under many constraints
- How can we consider all aspects simultaneously?

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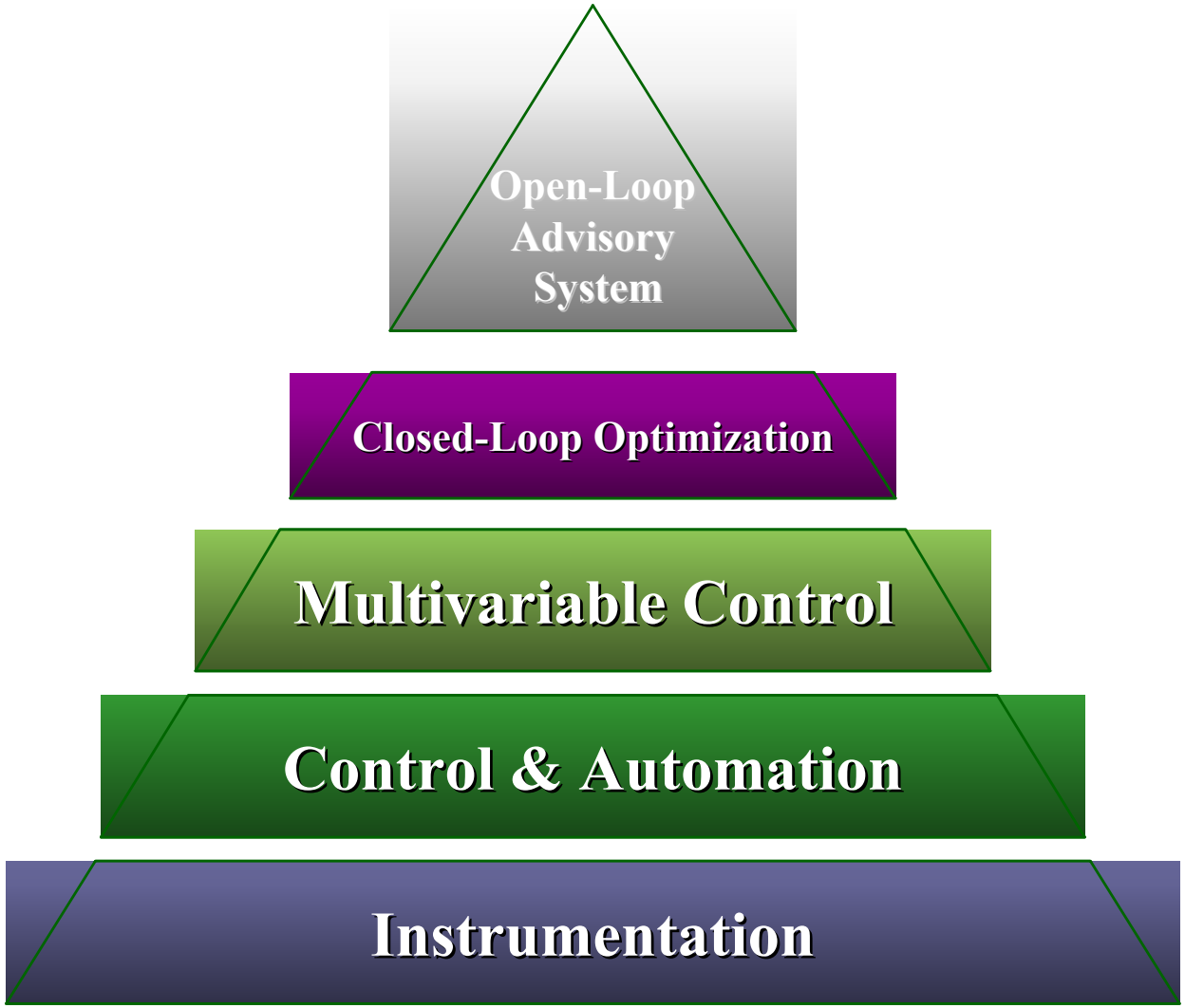
Optimization Pyramid



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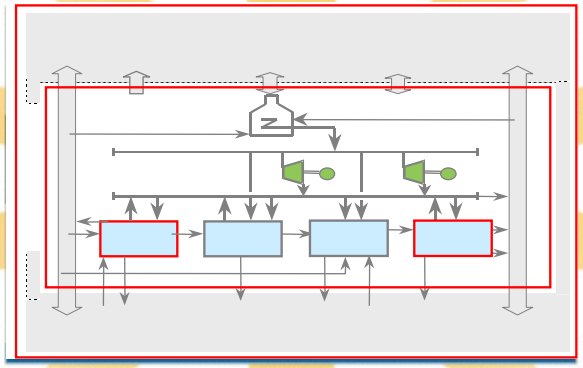
Life Cycle Energy Management



Investment Planning

Optimise capital for energy efficiency. Eliminate 'regret' capital.

Demand Forecasting

Based on production plans develop a forecast of steam, power and fuel usage

Utilities Production Planning

Use the demand forecast to set an optimum utilities production plan within existing constraints of equipment availability and emissions

Purchasing (tariff evaluation, supply, nominations)

Evaluate best tariffs; ability to reliably nominate supply requirements

Trading (power, CO_2, fuels)

Based on understanding of refinery requirements, set framework for trading (cost, availability etc.)

Optimal Plant Operation (on-line optimisation)

Provide on-line advice to operations personnel on current costs, lowest possible cost and the means to achieve this.

Contract Management

On-going management of contracts to minimise expensive penalties (maximum demand, take-or-pay etc.)

Performance Monitoring

Monitor energy usage of units and actual performance of utility equipment (boilers, turbines etc.)

Emissions Monitoring / Constraints

Evaluate emissions costs / constraints (CO_2, SO_x, NO_x)

Cost Accounting (real-time pricing)

Know the true current costs

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Lessons Learned

- Find the benefits
  1. What is 1% of your energy bill?
  2. What is your complexity and flexibility?
  3. Can you estimate the performance of the equipment?
- Get the benefits
  1. One time effort is not enough
  2. You must deal with whatever pushes away from the optimum
  3. Measurements are important
  4. Automation is the key to continued benefits

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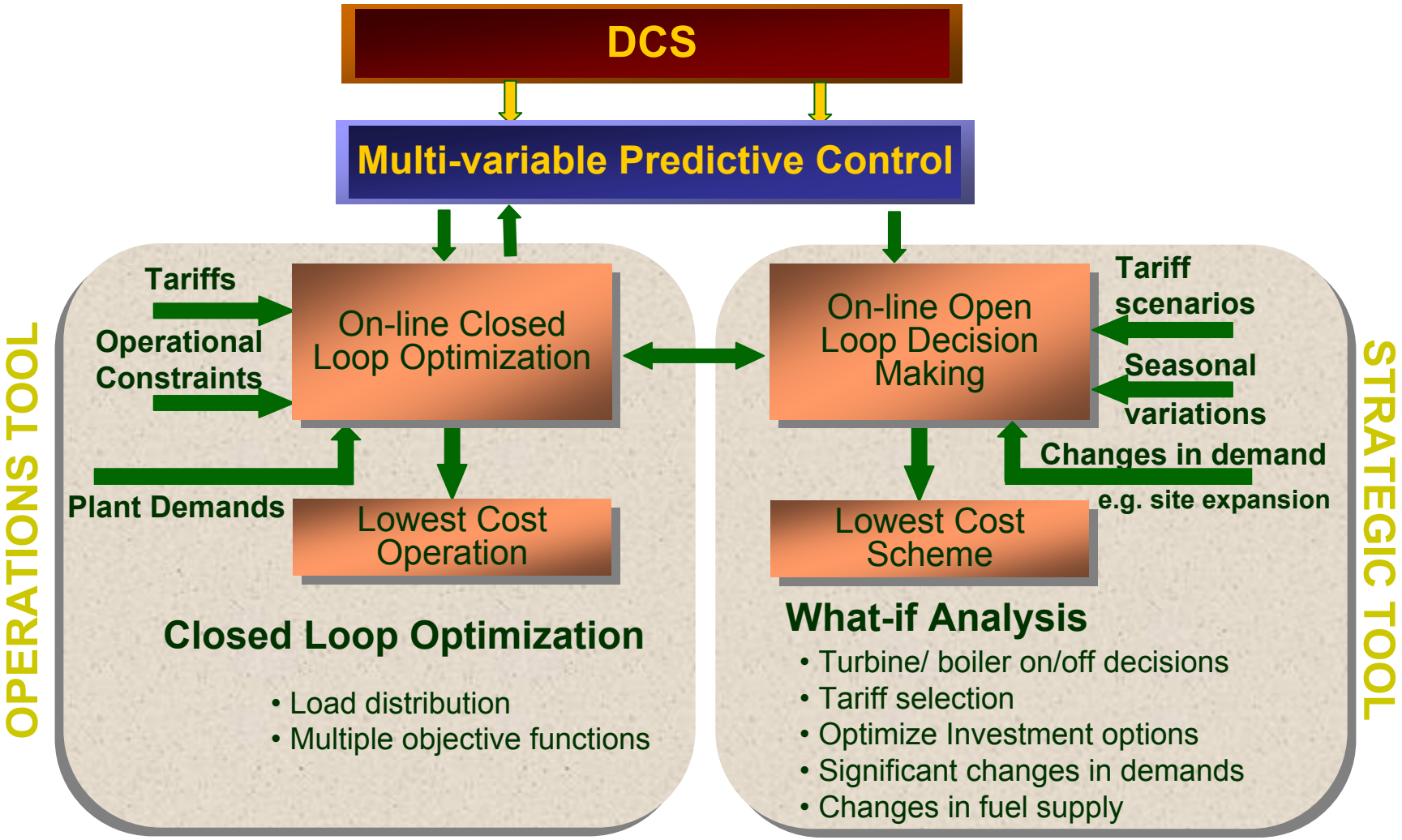
Aspen Utilities Solution Overview



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Strategic Solution - Advisory

- Solution Integrated/Consistent with Operation Solution
- Long-term Issues
  - Contract Selection/Negotiation
  - Capital Investment
- Short-medium term issues
  - Equipment selection optimization (on/off decisions)
  - Maintenance
  - Performance monitoring
- Optimization
  - MILP solver with multi-period optimization capability - can include process production planning
  - Off-line decision making / On-line decision support

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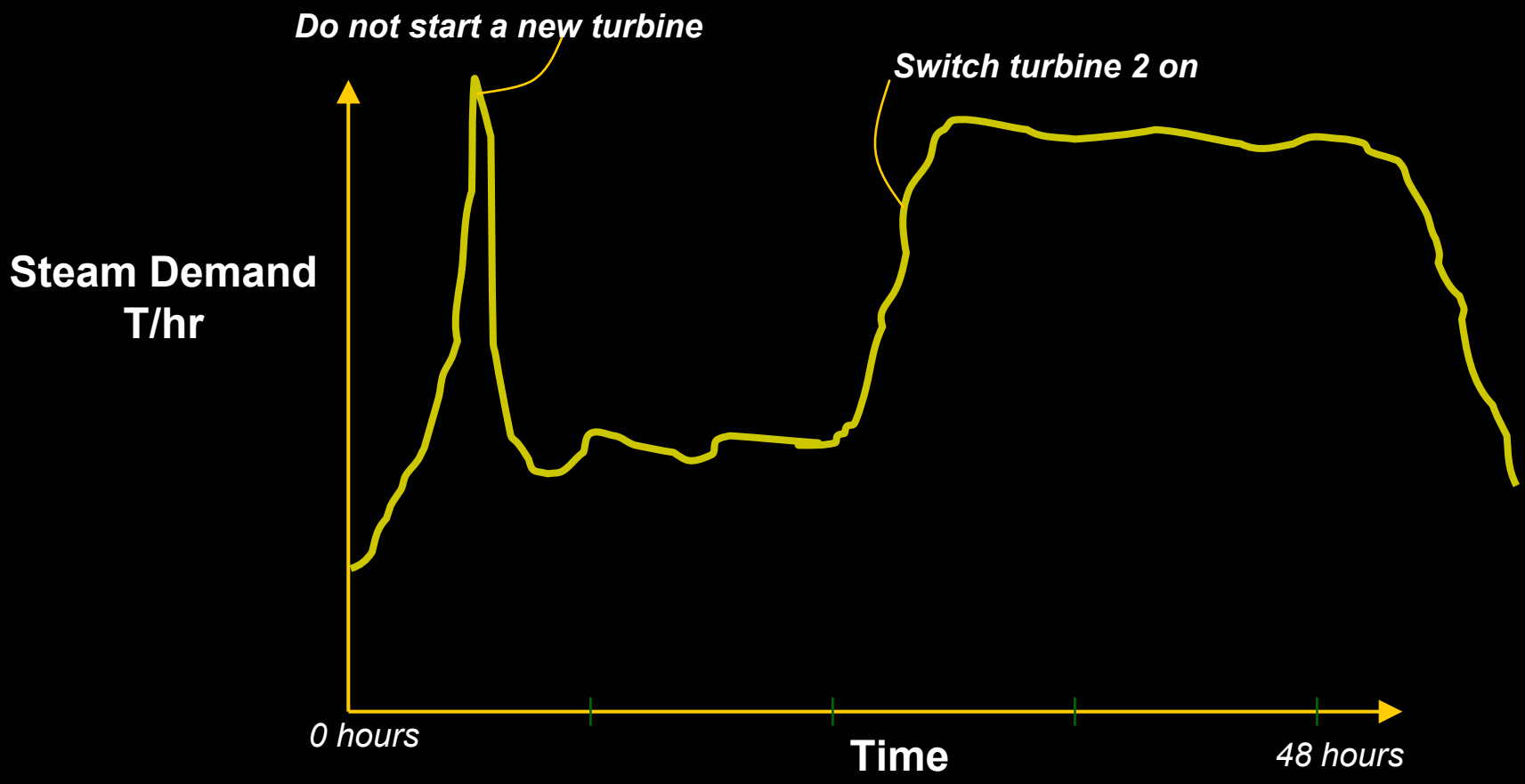
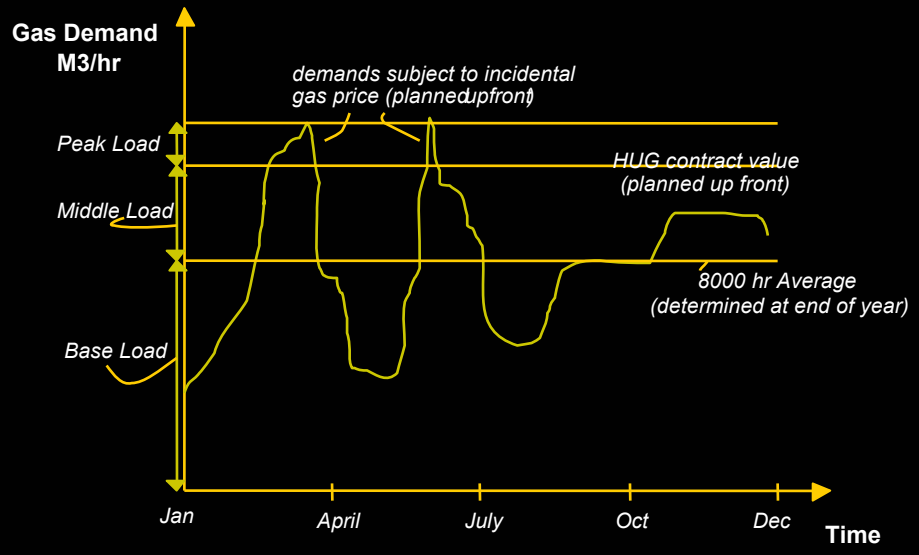
Demand Forecast

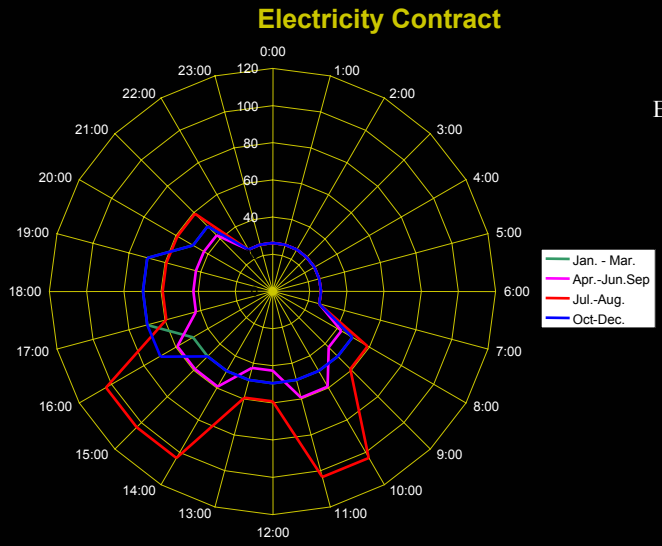


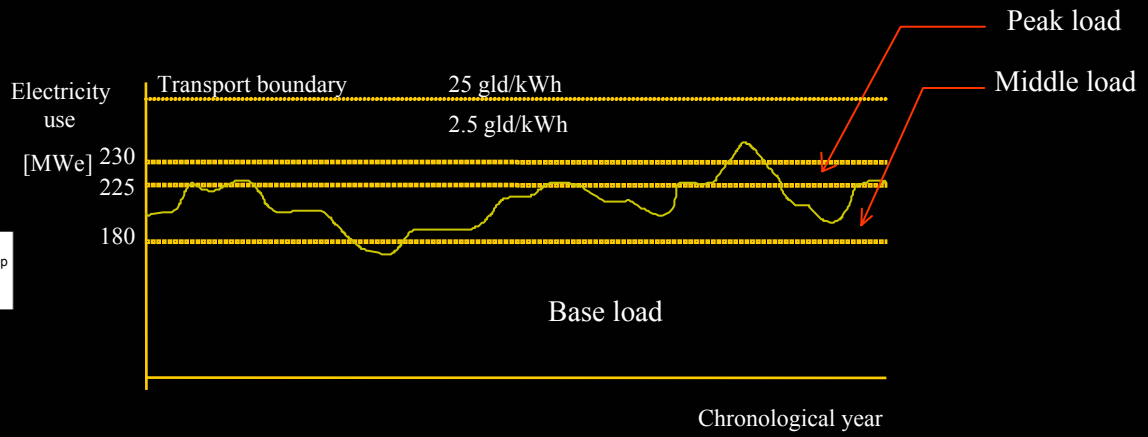
Considering steam demand profile behavior into optimization

Contract Optimization



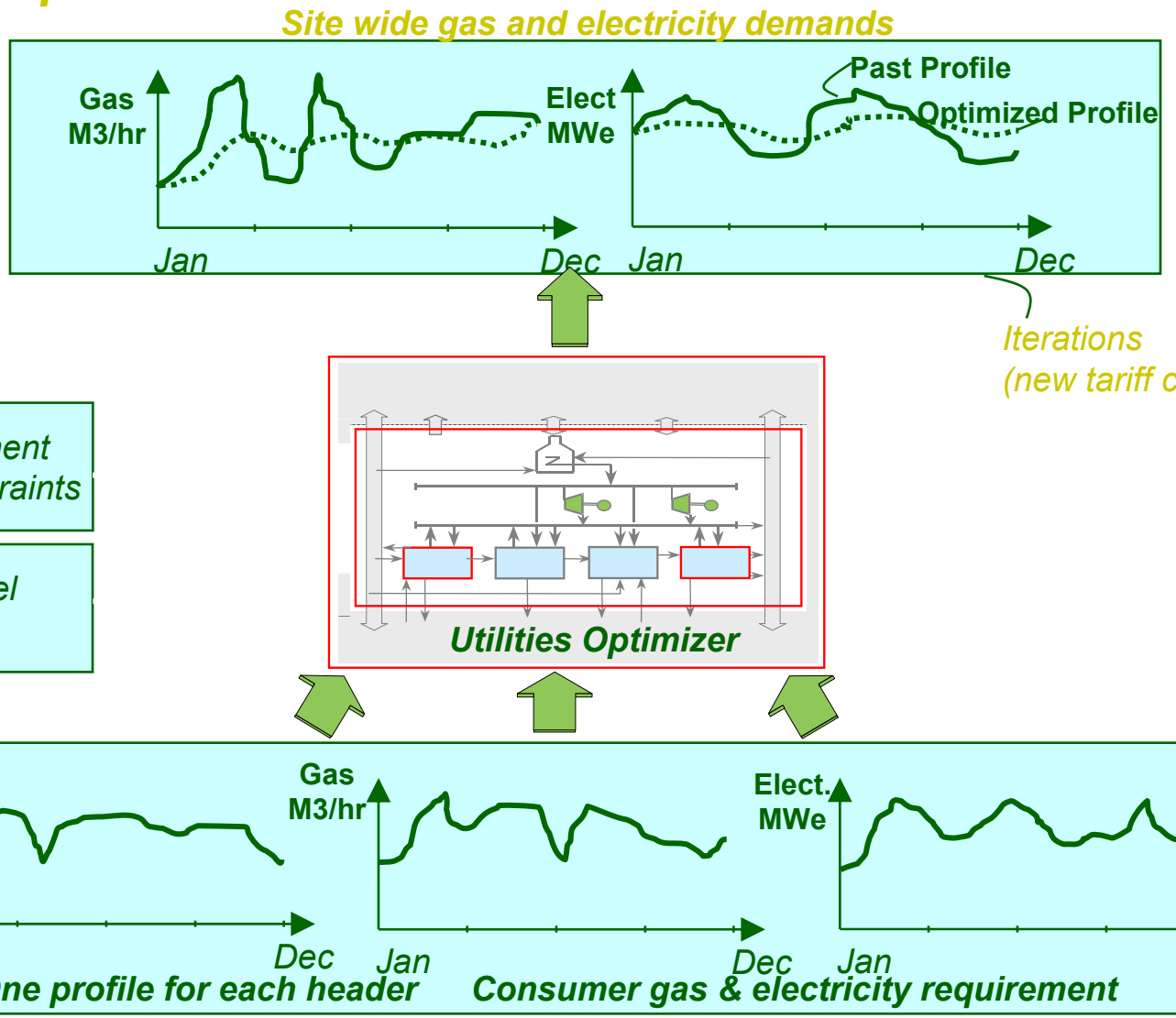
Gas Contract Structure





Elect. Contract Structure

Contract optimization



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Operations Solution – Closed Loop

- Tightly Integrated Package
  - Advanced Process Control - DMCplus
  - Real Time Optimization –AspenPlus Optimizer
  - Proven Reliability

- Integrated Goals
  - Tie line control
  - Constraint handling
  - Boiler, turbine load allocation
  - Performance Monitoring

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Operations – Closed Loop

- AspenPlus Optimizer calculates optimal operation for current state of process utilizing a rigorous model of process
  - Buy/Sell (within constraints)
  - Turbine/boiler loading
- DMCplus implements optimization targets and handles constraints and changes in demands and process between optimization solutions

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When Do You Need RTO ?

- High degree of non-linearity.
  - Can be fundamentally modeled.
- Frequent disturbances.
  - Correct time scale.
  - Changing economics and plant constraints.
- Significant degrees of freedom with substantial benefits.
  - Sufficient application scope.

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AspenPlus Optimizer

- Closed Loop Real Time Optimization
- Based on fundamental non-linear models
- Frequent optimization cycles
  - Model calibrated to plant each run (parameters updated)
  - Uses current economics and constraints
  - Cycle times of ~5 minutes
- Handles complex Constraints
- Handles tier pricing
- Consistency with APC and Strategic Model
- Facilitates performance monitoring

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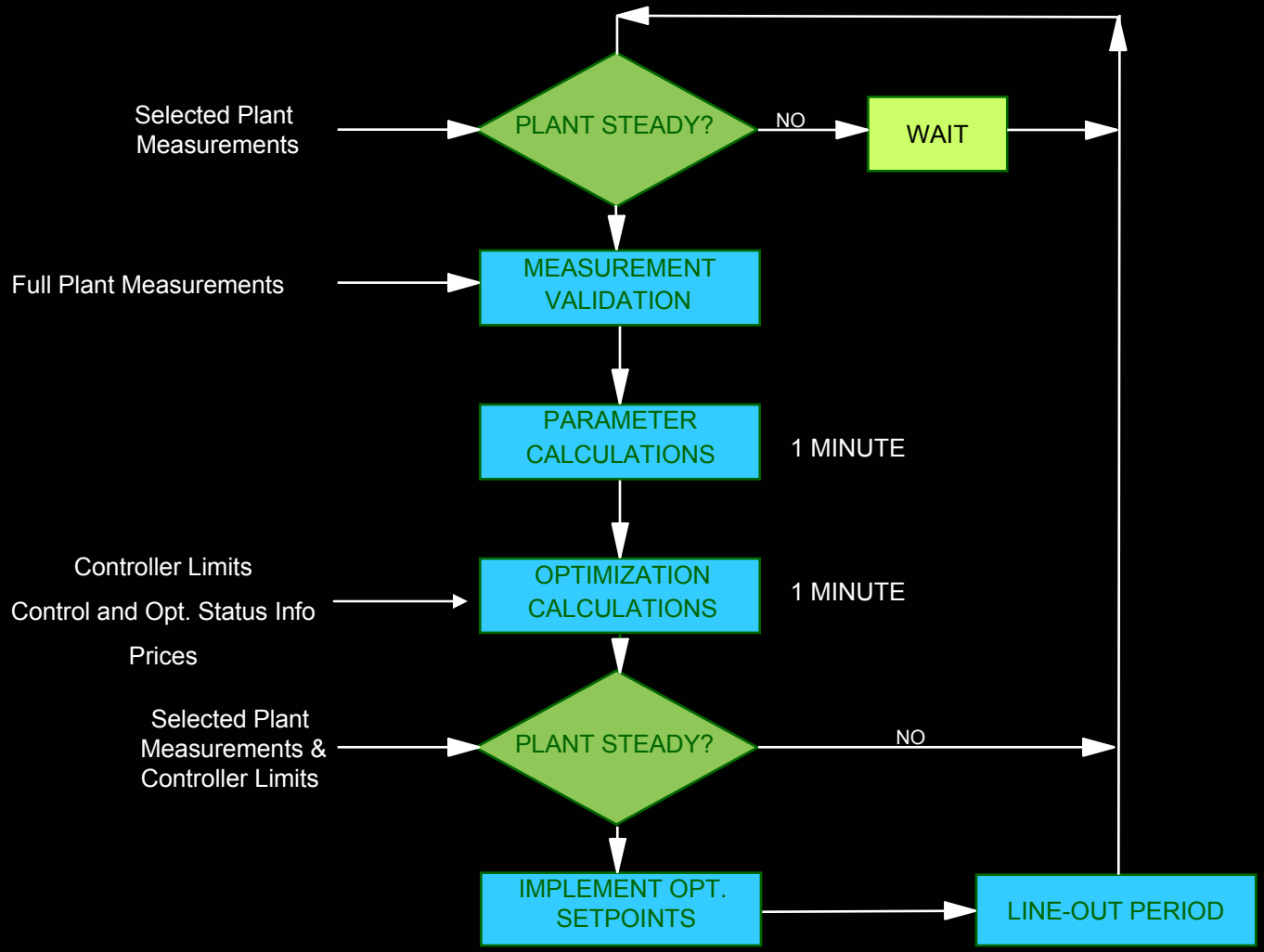
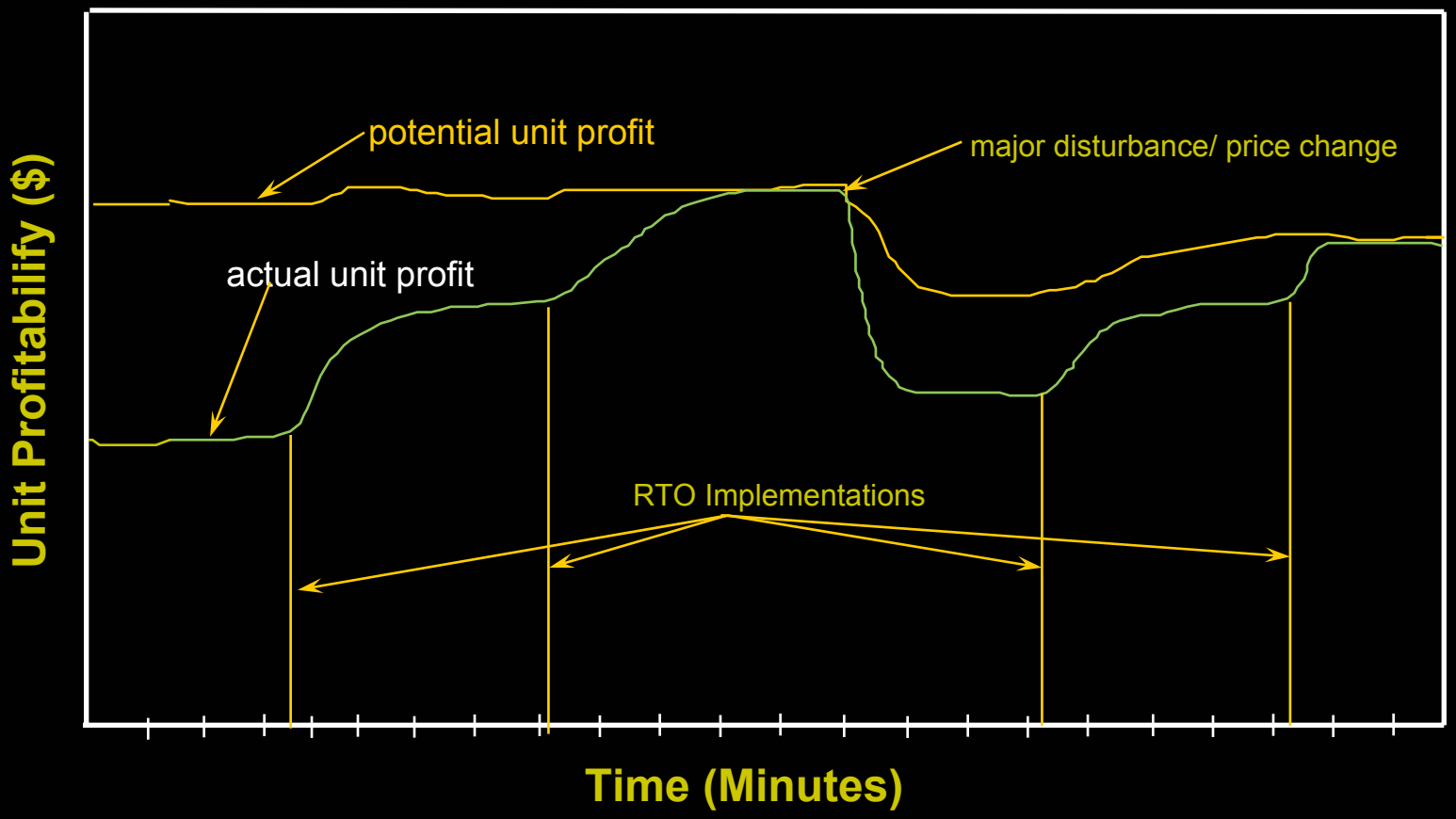
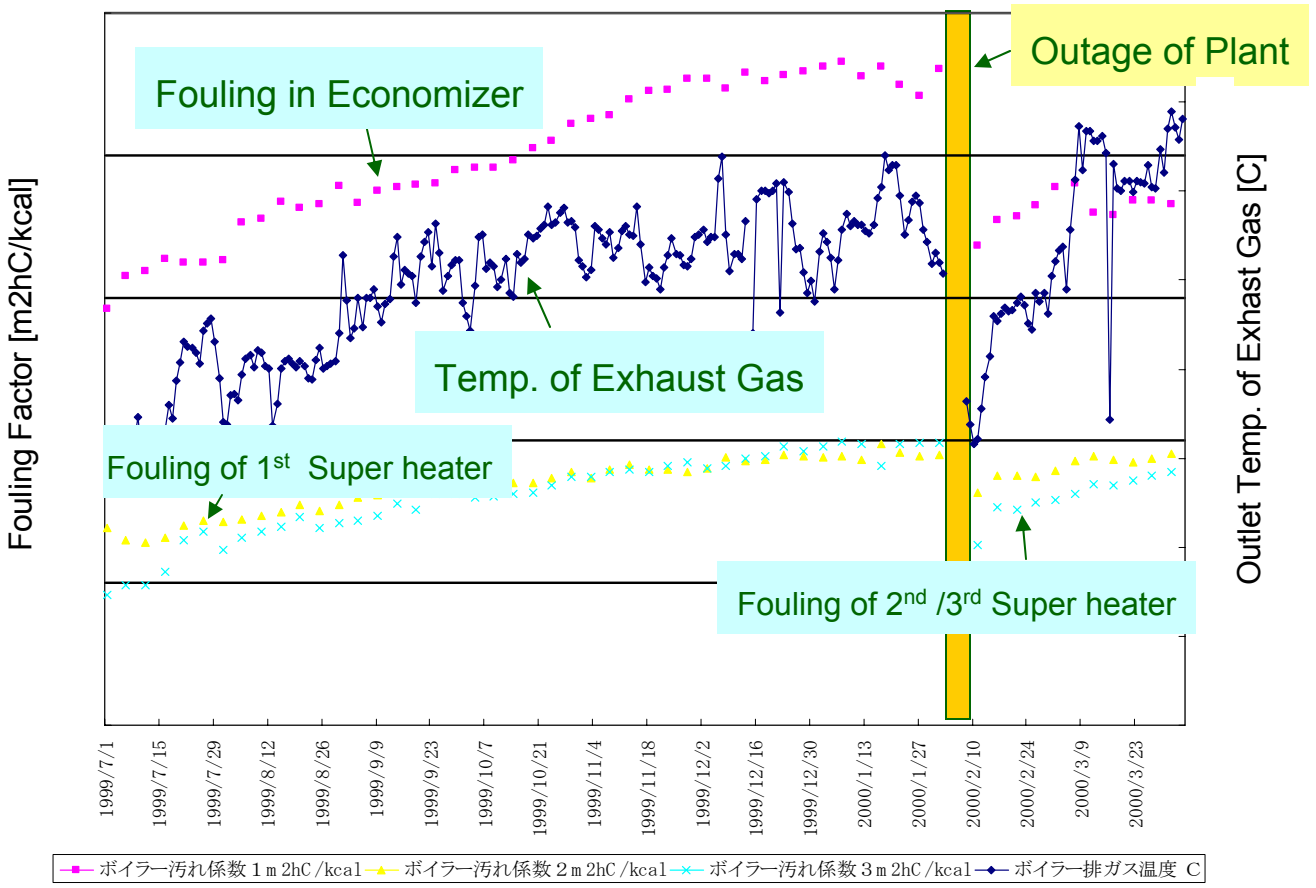
Closed Loop Optimization Sequence



Closed Loop Optimization Benefits



Analysis & Management of Boiler Fouling



-Strong correlations between Boiler Fouling and Outlet Temp. of Exhaust Gas

- Assumed the fouling was removed by Thermal shock at the outage of Plant

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DMCplus

- Dynamic multivariable control
  - Moves multiple variables simultaneously
  - Controls multiple variables simultaneously
- Operates at a scheduled high frequency
  - Typically 15 sec. in utilities plant
- Reduces variability in key variables
- Honors constraints
- Automatically handles reconfiguration of equipment and control system

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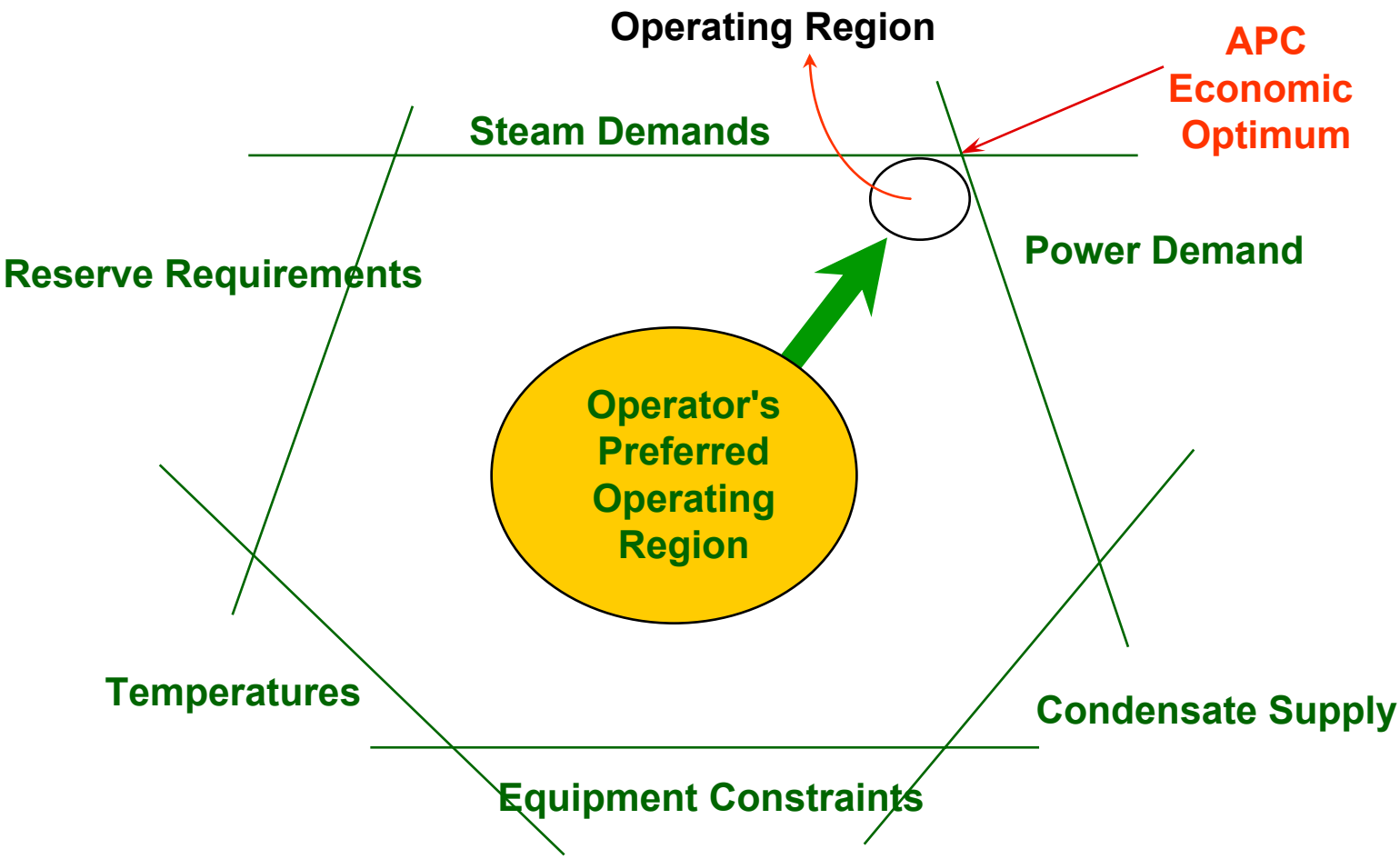
Benefits of DMCplus



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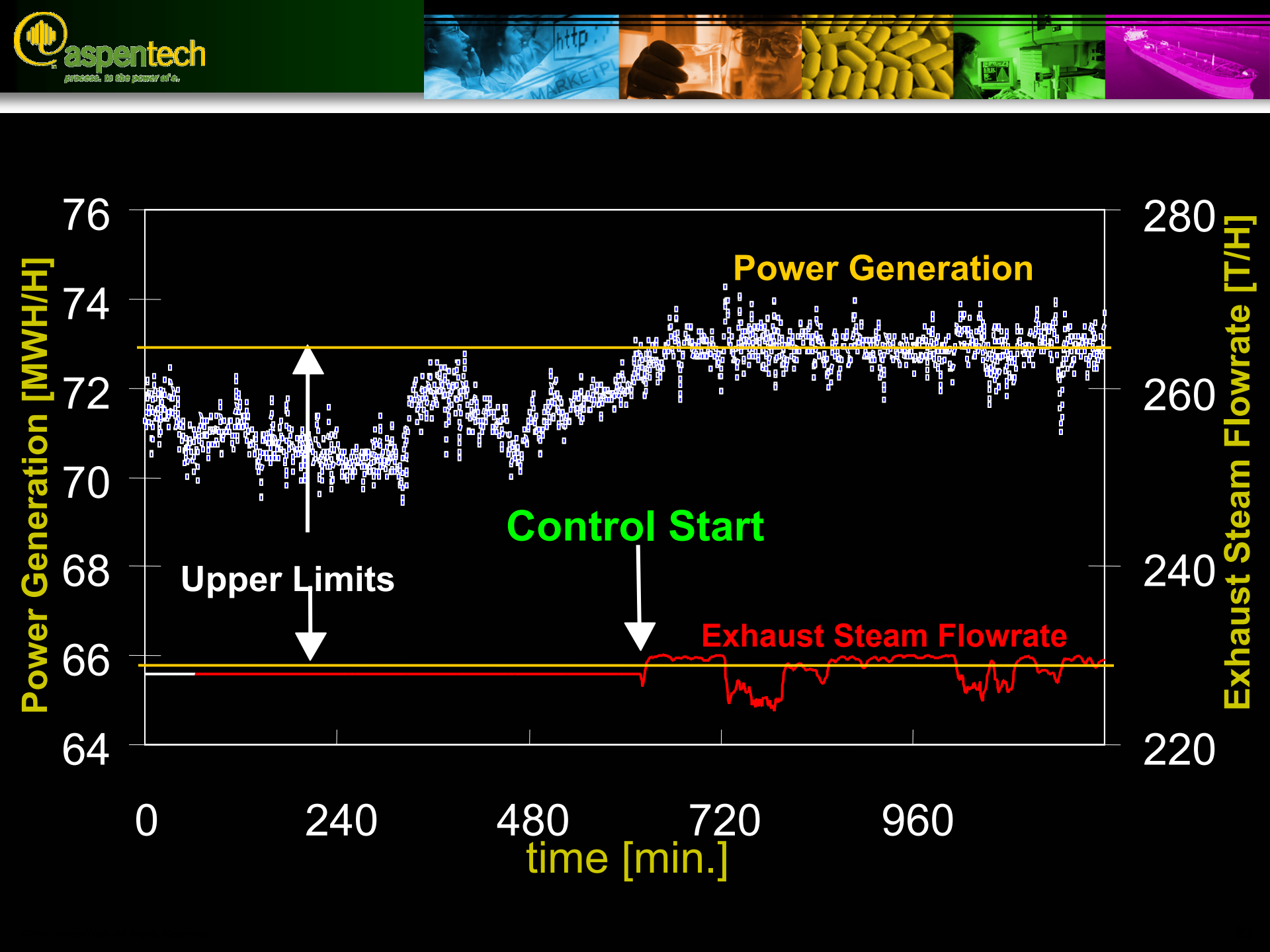
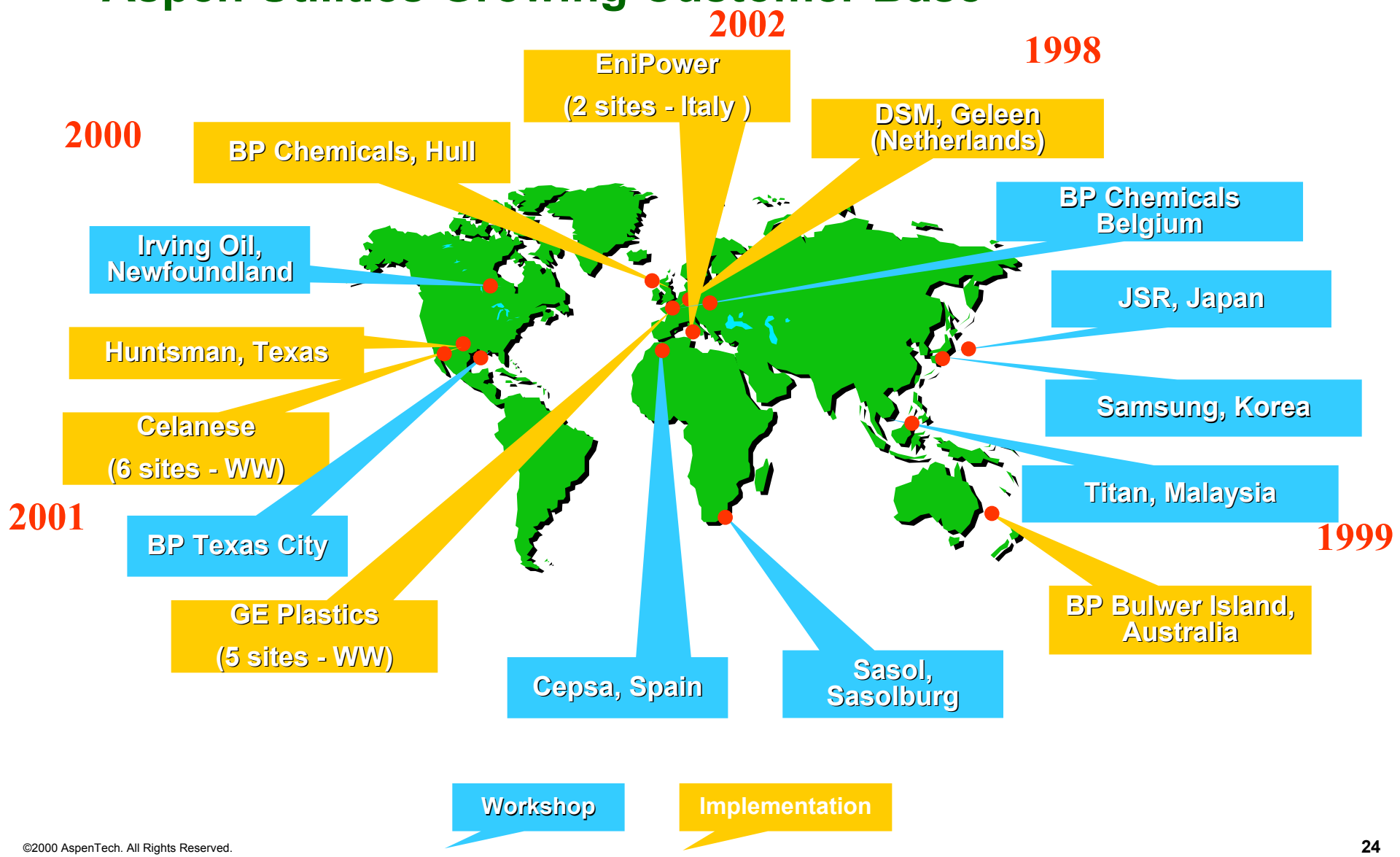

Power Generation
Control Start
Upper Limits
Exhaust Steam Flowrate
Power Generation [MWH/H]
Exhaust Steam Flowrate [T/H]
time [min.]
76
74
72
70
68
66
64
280
260
240
220
0
240
480
720
960

Aspen Utilities Growing Customer Base



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Utilities Management & Optimization

- Benefits
  - Significant benefits possible
    - **1.5-5% reduction in site-wide energy bill**
  - Provides a consistent approach for all the utilities related management and operations issues
    - **Consistent decision making from contracts to operation**
- AspenTech Approach
  - Systematic project approach - ***Energy Workshop***

Software + **Technology Transfer** + **Project Services** =

Complete Solution

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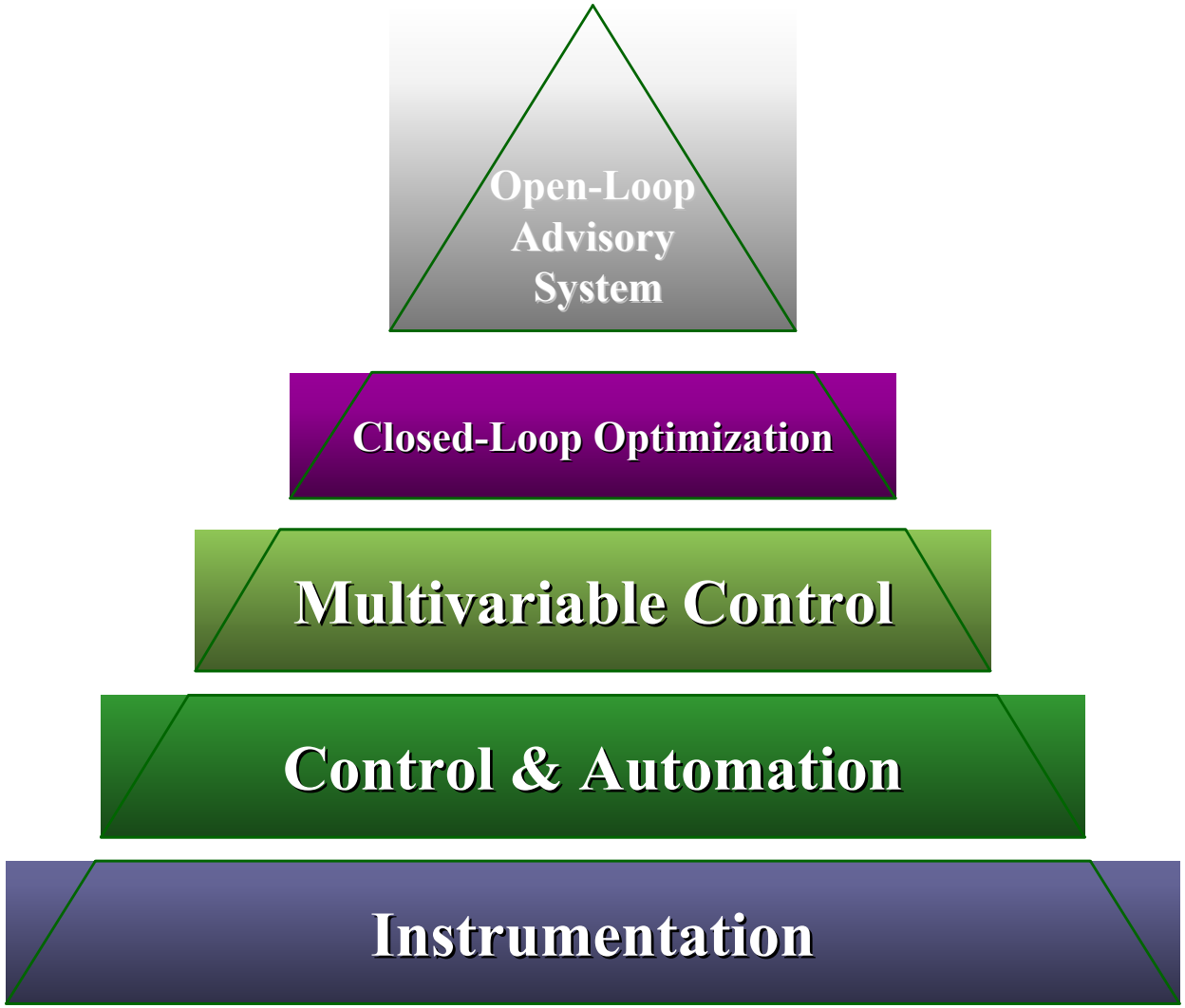
Optimization Pyramid



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CONTROL

CLOSED-LOOP
OPTIMIZATION

STRATEGIC
DECISIONS

To be successful you need to do all aspects well !!

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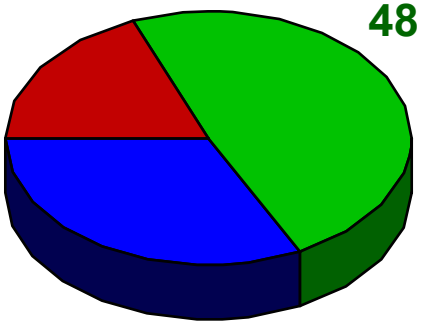
Thank You

AspenTech is the World Leader in APC & Optimization

Business Breakdown

Other 18.9 %
- Polymers
- Air Separation
- Specialty Chem
- Power

Refining 48.6 %



Olefins 32.5 %

Clients Include:

Most Major Oil Companies
Most Major Chemical Companies
Most Major Olefins Producers
More than 1,000 successful projects
More than 300 full plant online optimization applications

PROVEN integration with all leading DCS platforms including:

Yokogawa, Bailey, Foxboro, ABB, Honeywell, Fisher-Rosemount

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